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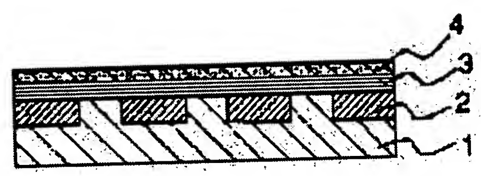
(54) PERPENDICULAR MAGNETIC RECORDING MEDIUM AND ITS PRODUCTION

(57)Abstract:

PURPOSE: To produce a perpendicular magnetic recording medium having a servo-pattern small in surface unevenness and to provide its producing method.



CONSTITUTION: A magnetic characteristic such as magnetic anisotropy, residual magnetization and coercieve force of a magnetic film 3 is selectively changed in accordance with the servo-pattern by partially changing the presence or absence and the film thickness, etc., of an under coat film 2 for controlling an orientation of the magnetic film 3, in accordance with a servo-pattern or by subjecting the magnetic film to laser-annealing. Then, a signal generated when the pattern is scanned with a magnetic head is used as a servo-signal for positioning of the magnetic head. And, a ROM pattern is formed by the same method.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the magnetic storage using the vertical-magnetic-recording medium which has high recording density especially, and its record medium with respect to the magnetic-recording medium used for informational record, and its manufacture approach.
[0002]
[Description of the Prior Art] The conventional magnetic-recording medium, for example, a magnetic disk, was manufactured by forming the magnetic-recording film by spin spreading, sputtering, etc. on the aluminium alloy substrate by which NiP plating was carried out. The large film (henceforth the magnetization film within a field) of a magnetic anisotropy or the film (slanting orientation film) which has a magnetic anisotropy perpendicularly to a film surface in the large film (henceforth perpendicular magnetic anisotropy films) or the direction of slant of a magnetic anisotropy is used for the magnetic film for magnetic recording at film surface inboard. If it records on these magnetic-recording medium, by the magnetization film within a field, a perpendicular magnetic domain will be formed in perpendicular magnetic anisotropy films, and a slanting magnetic domain will be formed for the magnetic domain within a field with the slanting orientation film. Among these, it is known that especially the magnetic recording (vertical magnetic recording) using perpendicular magnetic anisotropy films is suitable for record of high density [application physics, 63 (3), and 240 (1994) reference].
[0003] The above-mentioned magnetic disk is structurally [magnetically and] uniform and smooth, the writing of a servo signal was performed by the so-called servo track lighting method, and high recording density-ization has been attained by adoption and the reduction in surfacing of a surfacing head, and narrow gap-ization between a disk and a head [application physics, 63 (3), and 268 (1994) reference]. However, this method had the problem that recording density, especially truck number density are low, and the problem that productivity was low. Then, the code track separated magnetically was formed on the disk, and examination of the servo system which acquires a positioning signal optically was performed [the Institute of Electronics, Information and Communication Engineers paper magazines, such as two, C-II, J75-C-11,567 (1992)]. However, this method needs to carry optics, such as semiconductor laser, in the magnetic head, in order to acquire a positioning signal optically, and it has the problem from which the configuration of the magnetic head becomes very complicated compared with the former.
[0004] Collection SC[of the 1994 Institute of Electronics, Information and Communication Engineers spring convention drafts, such as [Furukawa where the magnetic disk which formed the magnetic-recording film uniformly on the plus tex substrate in which the concavo-convex servo pattern was formed on the front face in order to solve the above-mentioned problem is also proposed,]-3-5].
[0005]
[Problem(s) to be Solved by the Invention] the above-mentioned collection of the 1994 Institute of Electronics, Information and Communication Engineers spring convention drafts -- a technique given in SC-3-5 is related with the magnetization film within a field. Furthermore, this technique prepares the

irregularity of about 200nm in a front face as a servo pattern. Although the reduction in surfacing of the magnetic head is indispensable to a raise in recording density as above-mentioned, if the magnetic head is low-surfaced on a substrate with such surface irregularity, disk crash will occur.
[0006] Moreover, with the conventional magnetic disk, data-logging parts other than a servo signal were also structurally [magnetically and] uniform, and in order to have to perform the writing of the data only for playbacks for every magnetic disk drive, there was a problem that productivity was low. The purpose of this invention is in the perpendicular magnetic anisotropy films which can record high density more to offer the vertical-magnetic-recording medium which has the servo pattern of the very small embedding mold of surface irregularity, or a memory pattern only for playbacks (ROM pattern), and its manufacture approach.
[0007]
[Means for Solving the Problem] The vertical-magnetic-recording medium by this invention is characterized by making into the servo signal for magnetic-head positioning, or the memory signal only for playbacks the signal generated when it has the field which changed vertical magnetic properties to the film surface of a magnetic film alternatively according to the predetermined pattern and said field is scanned by the magnetic head.
[0008] Said magnetic properties are the product of a magnetic anisotropy, residual magnetization, residual magnetization, and thickness, or coercive force, and can make the field to which said magnetic properties were changed alternatively generate a magnetic domain alternatively by changing reinforcement and impressing the field which made the magnetic-recording medium reverse a polarity. Moreover, the vertical-magnetic-recording medium by this invention prepares the substrate film for orientation control of a magnetic film between a nonmagnetic substrate and a magnetic film, and is characterized by forming the servo pattern for magnetic-head positioning, or the memory pattern only for playbacks in the substrate film. Pattern formation to the substrate film can be performed by changing the existence of the substrate film, thickness, or an ingredient. The substrate film for orientation control of a magnetic film can be set to Ti, Ru, germanium, Zr, or Cr, and a magnetic film can be made into Co-Cr, Co-Cr-Ta, or Co-Cr-Pt.
[0009] The condition of the existence of the substrate film or the vertical-magnetic-recording medium of this invention into which thickness was changed can be manufactured according to the process which etches the part besides the individual reason equivalent to the servo pattern of a nonmagnetic substrate front face, or the memory pattern only for playbacks, the process which forms the substrate film for orientation control of a magnetic film in the etched part, and the process which forms a magnetic film on it. Moreover, it can manufacture according to the process which etches either of the parts besides the individual reason equivalent to the part equivalent to the servo pattern of the front face of a nonmagnetic substrate, or the memory pattern only for playbacks, a servo pattern, or the memory pattern only for playbacks, the process which form the substrate film of a magnetic film for orientation control on it, and the process door which grinds the front face of the substrate film and makes flat and the process which form a magnetic film on it. Or it can manufacture according to the process which etches the part besides the individual reason equivalent to the servo pattern of the front face of a nonmagnetic substrate, or the memory pattern only for playbacks, the process which forms orientation or the 1st substrate film for particle-size control in the etched part, the process which forms the 2nd substrate film for orientation control of a magnetic film on the 1st substrate film, and the process which form a magnetic film on it. Furthermore, it can manufacture according to the process which forms the substrate film for orientation control of a magnetic film on a nonmagnetic substrate, the process which removes the substrate film of the part equivalent to a servo pattern or the memory pattern only for playbacks, and the process which forms a magnetic film on it.
[0010] What is necessary is to form the 1st substrate film on a nonmagnetic substrate, to remove the part equivalent to the servo pattern of the 1st substrate film, or the memory pattern only for playbacks, and just to form the 2nd substrate film in the removed part, in order to change partially the ingredient of the substrate film for orientation control of a magnetic film according to a servo pattern or the memory pattern only for playbacks.

[0011] When an oxidizing zone generates on a substrate film front face by processing the substrate film out of a vacuum, it is suitable to include the process which carries out sputter etching of the substrate film front face before the process which forms a magnetic film, and removes an oxidizing zone, when improving the stacking tendency of a magnetic film. the perpendicular magnetic properties of a magnetic film also heat the part besides the individual reason equivalent to the servo pattern of a magnetic film, or the memory pattern only for playbacks with laser -- change ****** -- things are made.

[0012]
[Function] If the magnetic properties of the perpendicular direction of the magnetic film which constitutes a magnetic storage medium are alternatively changed according to a servo pattern and a magnetic domain is formed there alternatively, existence of the servo pattern is electrically detectable. By moving the location of the head which has a detection function part so that the amplitude of the detecting signal may become the predetermined range, the relative position of a recording information train and the magnetic head which performs informational I/O can be amended. Thereby, the same alignment as the conventional magnetic disk drive can be performed.
[0013] Read-out of the memory pattern only for playbacks (ROM pattern) also becomes possible by the same configuration. When the substrate film for orientation control of a magnetic film exists between a nonmagnetic substrate and a magnetic film, pattern formation is performed on the substrate film, and if a magnetic film is put on this substrate film after forming alternatively the field where the substrate film exists, and the field not existing, magnetic properties, such as a product of the magnetic anisotropy of the magnetic film by which a laminating is carried out on it according to the existence of the existence of the substrate film, residual magnetization, residual magnetization, and thickness, or coercive force, will change.
[0014] Thus, a field strong against a field including the field to which magnetic properties were changed is impressed, and magnetization of all fields is saturated. Then, if the field from which the polarity which adjusted reinforcement differs is impressed, the condition (magnetic domain) that the magnetization directions differed in the field where magnetic properties changed, and other fields can be made. The field which magnetic properties changed can be made to generate a magnetic domain alternatively by the above actuation. Moreover, since a servo pattern is formed using the process of photolithography, the precision of a pattern can be raised rather than record by the servo writer.
[0015]
[Example] Hereafter, an example explains this invention to a detail.
[Example 1] The magnetic-recording medium of the shape of a disk which shows a top view to drawing 3 was produced. Only the servo field 20 which extends in the disk radial is simplified to drawing 3 , and it is shown in it. As the part is expanded and shown in a downward circle, it is inserted into the servo field 20 by the clock patterns 21 and 22 and the clock patterns 24 and 25, and the servo pattern 23 is formed in it. A recording track is set as a disk circumferencial direction so that the servo field 20 may be intersected, and data and a program are formed in some trucks as the memory only for playbacks, i.e., a ROM pattern, by the servo pattern 23, the clock patterns 21 and 22, and the formation approach and the same approach of --. Drawing 1 is the A-A cross section of drawing 3 .
[0016] The production process of this magnetic-recording medium is explained using drawing 2 . Drawing 2 is drawing equivalent to the A-A cross section of drawing 3 . The quartz-glass substrate 1 with a diameter of 2.5 inches with which the hole with a diameter of 20mm opened was first prepared for the core [drawing 2 (a)]. Next, it left the resist film 30 alternatively as were shown in drawing 2 (b), and the resist 30 was applied on the front face of this substrate 1, and pattern exposure was carried out, negatives were developed by the photolithography method used in manufacture processes, such as a semiconductor device, as shown in the servo field 20 on a substrate 1 in the circle of drawing 3 and it was shown in drawing 2 (c). After an appropriate time, by reactive ion etching of a Freon system, 70nm of fields without the resist film 30 of the quartz-glass substrate 1 was etched alternatively, and the desired concavo-convex pattern was formed in quartz-glass substrate 1 front face like drawing 2 (d).
[0017] Next, 70nm of Ti was formed as substrate film 2 as Ar ambient atmosphere and conditions with a

pressure of 0.2Pa showed to the substrate 1 at drawing 2 (e). then -- the [lift-off method for having dissolved the above-mentioned resist film in the acetone, and having removed Ti substrate film 2 on it with the resist film by the lift-off method -- for example, refer to the 190 pages (Showa 60) of work "optical integrated circuit" Ohm-Sha besides Nishihara --] .
[0018] When the test piece with a diameter of 10mm which consists of the same ingredient as this sample and the sample processed to coincidence was observed by SEM, Ti substrate film 2 was embedded like drawing 2 (f) to the field to which the quartz-glass substrate 1 was etched. Consequently, in two or more servo fields 20 which cross a recording track and are established in the radial, as expanded and shown in the circle of drawing 3 , Ti substrate film 2 was embedded in parts other than the clock patterns 21 and 22, the servo pattern 23 and the clock pattern 24, and 25. In this example, width of face of the clock patterns 21, 22, 24, and 25 was set to 2 micrometers, and the servo pattern 23 was made into width of face of 2 micrometers, and an ellipse with a die length of 5 micrometers. However, these dimensions or the number is a thing for mere instantiation, and does not limit this invention.
[0019] Then, after carrying out sputtering of this sample front face lightly, on Ar ambient atmosphere and conditions with a pressure of 70Pa, as shown in drawing 2 (g), 50nm of CoCr(s)17 was formed as a magnetic film 3, and, finally 10nm of carbon was formed on Ar ambient atmosphere and conditions with a pressure of 0.2Pa as a protective coat 4 like drawing 2 (h). The place which measured the vertical residual magnetization Mr with the oscillatory type sample magnetization measuring device (VSM) at vertical coercive force Hc and a vertical film surface to the film surface of the magnetic film 3 in a magnetic-recording medium, the field which has Ti substrate film 2 using the test piece produced to coincidence, and the field which is not, a field with Ti substrate film 2 -- Hc -- 1530 -- the field which Oe(s) and whose Mr are 510 emu(s)/cc, and does not have Ti substrate film 2 -- Hc -- 500 -- Oe(s) and Mr were 470 emu(s)/cc.
[0020] Thus, in a field with the substrate film 2, and the field which is not, the magnetic properties of the magnetic film 3 formed on it differ. As shown in drawing 4 (a) using the difference in Hc of these two fields, it begins, a strong field is generated from the magnetic head 40, DC demagnetization of the magnetic film 3 is carried out to a film surface perpendicular direction, next, if DC demagnetization is carried out by the small field which changed the polarity as shown in drawing 4 (b), the sense of magnetization will reverse only the small field of Hc, and the magnetic domain corresponding to the existence of the substrate film is formed. Among drawing, a field 13 expresses the small field of the vertical coercive force Hc, and a field 14 expresses the big field of Hc. As shown in drawing 4 (c), in perpendicular magnetic anisotropy films, the above-mentioned magnetic domain exists in stability from the effectiveness of the anti-field 41.
[0021] Therefore, if it passes through the servo field 20 where the magnetic head is positioned on a recording track as a continuous line shows to drawing 5 (a), a detecting signal like drawing 5 (b) will be obtained. On the other hand, if it passes through a servo field in the condition of having shifted from the recording track as a broken line shows to drawing 5 (a), a servo signal as shifted from the direction of the gap and shown in drawing 5 (c) according to an amount will occur. A magnetic recording medium controls the truck cross direction location of the magnetic head to approach a wave as a detecting signal shows to drawing 5 (b), and positions the magnetic head to a magnetic-recording medium.
[0022] After building said magnetic-recording medium into the magnetic storage which shows an outline to drawing 12 , as drawing 4 explained, it demagnetized twice by DC field which changed the polarity and magnitude. However, demagnetization by DC field may be performed before building a magnetic-recording medium into magnetic storage. Magnetic storage is the thing of the configuration of the common knowledge which has the read/write (R/W) device section, a recovery, a control system, and the signal-processing section. The magnetic head is a record playback discrete-type head which equipped writing with the induction type thin film head, and equipped signal reading with the magnetic-reluctance (MR) head. The data generated in the signal-processing section are changed into an analog signal with a D/A converter, and are sent to the magnetic head. The magnetic signal read from the magnetic-recording medium by which a rotation drive is carried out by the motor by the MR head is inputted into a clock mark detection circuit, a data regenerative circuit, and a tracking signal generation

circuit through a R/W circuit. In response to the clock mark detection signal from a clock mark detection circuit, a PLL clock regenerative circuit reproduces a PLL clock. A PLL clock is inputted into a tracking signal generation circuit, a data regenerative circuit, and the signal-processing section.
[0023] In a tracking signal generation circuit, a window is opened according to the inputted PLL clock, and a tracking signal is generated from the signal inputted from a R/W circuit. A tracking control circuit outputs a driving signal to the power driver of the actuator which positions the magnetic head based on a tracking signal, and performs follow-up control of the magnetic head to a truck. On the other hand, in a data regenerative circuit, a window is opened according to the inputted PLL clock, and a data signal is generated from the signal inputted from a R/W circuit together with the signal inputted from the signal-processing section, it inputs into the signal-processing section, and data are read.
[0024] When it reproduced by spacing 0.07micrometer and peripheral-speed 10 m/s using the MR head, the positioning signal was able to be acquired by S/N ratio 5.2. When the magnetic head was positioned and playback of data was tried on the truck in which the ROM pattern was formed on this condition, the data corresponding to a pattern were obtained by S/N ratio 3.8. The same result was obtained also when Ru film, germanium film, and Zr film were formed instead of Ti film as substrate film 2. In the field with the substrate film 2 of each film, and the field which is not, when the vertical residual magnetization Mr was measured with the oscillatory type sample magnetization measuring device to the film surface of a magnetic film 3 at vertical coercive force Hc and a vertical film surface, the following measured value was obtained.
[0025]
Substrate film ingredient Existence Hc (Oe) Mr (emu/cc)
Ru It is. 1480 520 Nothing 510 480 germanium It is. 1450 510 Nothing 500 480 Zr It is. 1410 500 **** 500 Although the quartz-glass substrate was used as a substrate 1 in 470 this example, the same result was obtained even if it used for example, Si substrate and the thermal oxidation Si substrate for others.
[0026] [Example 2] Drawing 6 is a cross section equivalent to drawing 1 of other examples of the magnetic-recording medium by this invention. Although the servo pattern was formed by the existence of the substrate film in the example 1, the servo pattern was formed in this example by changing alternatively the thickness of Ti film which is substrate film. The formation approach of a servo pattern is as follows.
[0027] The resist pattern was first formed by the photolithography method like drawing 2 (b) and (c) on the front face with a diameter of 2.5 inches of the Si substrate 1. This resist film is used as a mask and it is CF4. 40nm of Si substrates 1 was etched by reactive ion etching using gas. Next, dissolution removal of the resist film was carried out with the acetone, and 80nm sputtering membrane formation of the Ti substrate film 2 was carried out on the concave convex of the Si substrate 1. Then, tape polish of the Ti substrate film 2 was carried out, the front face was made flat, and the thickness of the Ti film 2 was changed corresponding to the irregularity of the Si substrate 1. Sputter etching of the obtained Ti substrate film 2 was carried out lightly, the front face was made into clarification, 50nm spatter membrane formation of CoCr17 was carried out as a magnetic film 3 on it, and 10nm spatter membrane formation of the carbon film was carried out as a protective coat 4 on it. Furthermore, lubricant 11 was applied on the carbon protective coat 4.
[0028] Ti substrate film 2 measured the vertical residual magnetization Mr with the oscillatory type sample magnetization measuring device at vertical coercive force Hc and a vertical film surface using the test piece produced to a magnetic-recording medium and coincidence to the film surface of the magnetic film 3 in a thick field and a thin field. consequently -- the thick field of Ti substrate film 2 -- Hc -- 1100 -- Oe(s) and Mr -- 480 emu(s)/cc -- the thin field of ** and Ti substrate film 6 -- Hc -- 1570 - - Oe(s) and Mr were 500 emu(s)/cc. As drawing 4 explained this magnetic-recording medium, after demagnetizing twice by DC field which changed that polarity and magnitude, when it included in the magnetic storage of the common knowledge which shows an outline to drawing 12 and reproduced by spacing 0.07micrometer and peripheral-speed 10 m/s using the MR head, the positioning signal was able to be acquired by S/N ratio 4.6.
[0029] Although the above was the example which etched the part equivalent to the servo pattern of a

substrate 1, the same result was obtained even if it etched the part besides the individual reason equivalent to the servo pattern of a substrate 1. For example, after etching 20nm of substrates 1, 30nm of Ti film was formed as substrate film on it. and the place where Ti substrate film measured the vertical residual magnetization Mr with the oscillatory type sample magnetization measuring device to the film surface of the magnetic film in a thick field and a thin field at vertical coercive force Hc and a vertical film surface using the magnetic-recording medium, simultaneously the produced test piece -- the thick field of Ti substrate film -- Hc -- 1530 -- Oe(s) and Mr -- 510 emu(s)/cc -- it is -- the thin field of Ti substrate film -- Hc -- 1050 -- Oe(s) and Mr were 480 emu(s)/cc. Moreover, like the optical disk, although the quartz-glass substrate was used as a substrate 1 in this example, even if it used the polyether imide (PEI) substrate and amorphous Pori olefin (APO) substrate which were beforehand fabricated with irregularity by the injection-molding method, otherwise, the same result was obtained.
[0030] [Example 3] Drawing 7 is a cross section equivalent to drawing 1 of other examples of the magnetic-recording medium by this invention. Although considered as the structure which embedded Ti as substrate film at the quartz-glass substrate in the example 1, the substrate film which changes from two-layer to a front face on the front face using the thermal oxidation Si which has an oxide film with a thickness of 300nm as a substrate 1 was embedded by the lift-off method in this example.
[0031] TiCr10 film was carried out as first pass substrate film 6 formed on a substrate front face, and 20nm sputtering membrane formation of the Ti film was carried out as 30nm and second layer substrate film 5 on it. Then, sputter etching of the sample front face was carried out lightly, the front face was made into clarification, 100nm spatter membrane formation of CoCr19Pt12 was carried out as a magnetic film 3 on it, and 10nm spatter membrane formation of the carbon film was carried out as a protective coat 4 on it.
[0032] The vertical residual magnetization Mr was measured with the oscillatory type sample magnetization measuring device (VSM) at vertical coercive force Hc and a vertical film surface using the test piece produced to a magnetic-recording medium and coincidence to the film surface of the magnetic film 3 in a field with the substrate film which consists of two-layer [of the TiCr film 6 and the Ti film 5], and the field which is not. consequently -- a field with the substrate film -- Hc -- 2100 -- the field which Oe(s) and whose Mr are 490 emu(s)/cc, and does not have the substrate film -- Hc -- 500 -- Oe(s) and Mr were 440 emu(s)/cc. As drawing 4 explained this magnetic-recording medium, after demagnetizing twice by DC field which changed that polarity and magnitude, when it included in the magnetic storage of the common knowledge which shows an outline to drawing 12 and reproduced by spacing 0.07micrometer and peripheral-speed 10 m/s using the MR head, the positioning signal was able to be acquired by S/N ratio 6.4.
[0033] the field which has the substrate film even if it uses for example, germanium film for others, although TiCr10 film 6 was used as first pass substrate film in this example -- Hc -- 2100 -- the field which Oe(s) and Mr are set to 490 emu(s)/cc, and does not have the substrate film -- Hc -- 500 -- Oe(s) and Mr were set to 440 emu(s)/cc, and the same result was obtained. In the two-layer substrate film of this example, TiCr10 film which is first pass substrate film, and germanium film carry out the operation which mainly controls particle size, and Ti film which is the second layer substrate film carries out the operation which mainly controls the orientation of a crystal.
[0034] [Example 4] Drawing 8 is a cross section equivalent to drawing 1 of other examples of the magnetic-recording medium by this invention. Although the magnetic domain was formed in the examples 1-3 by forming the low field of magnetic properties alternatively into perpendicular magnetic anisotropy films although it is similarly perpendicular orientation, in this example, into perpendicular magnetic anisotropy films, the orientation field within a field was formed alternatively and the magnetic domain was formed. The approach is as follows.
[0035] 30nm sputtering membrane formation of the Ti film was carried out as substrate film 2 on the front face of the quartz substrate 1. Next, according to the servo pattern, the resist film was alternatively formed on Ti substrate film 2. Then, CCl4 By reactive ion etching using gas, 30nm of fields without the resist film of the quartz substrate 1 was etched alternatively, and the Cr film 15 which carried out sputtering membrane formation by the lift-off method was embedded. Sputter etching of the obtained

sample is carried out lightly after an appropriate time, and it is CoCr17Ta3 as a magnetic film 3 on it. Spatter membrane formation was carried out at the thickness of 100nm, and spatter membrane formation of the carbon film was carried out as a protective coat 4 on it at the thickness of 10nm.

[0036] The vertical residual magnetization Mr was measured with the oscillatory type sample magnetization measuring device at vertical coercive force Hc and a vertical film surface to the film surface of a magnetic film 3 in a magnetic-recording medium, the field which has Ti substrate film 2 using the test piece produced to coincidence, and the field which exists the Cr film 15. consequently -- a field with Ti substrate film 2 -- Hc -- 1810 -- the field which Oe(s) and whose Mr are 500 emu(s)/cc, and has the Cr film 15 -- Hc -- 950 -- Oe(s) and Mr were 110 emu(s)/cc. After carrying out DC demagnetization of this magnetic-recording medium in an one direction, when it included in the magnetic storage of the common knowledge which shows an outline to drawing 12 and reproduced by spacing 0.1micrometer and peripheral-speed 10 m/s using the MR head, the positioning signal was able to be acquired by S/N ratio 2.8.

[0037] [Example 5] Drawing 9 is a cross section equivalent to drawing 1 of other examples of the magnetic-recording medium by this invention. In this example, the high field of the vertical coercive force Hc was formed more into the magnetic film by heat-treating a magnetic film alternatively using laser. if in charge of production of a magnetic-recording medium -- the quartz substrate 1 top -- as substrate film 2, CoCr17 film was carried out as 30nm and a magnetic film 3, and 10nm spatter membrane formation of the carbon film was carried out for Ti film as 30nm and a protective coat 4. Laser annealing of the obtained sample was alternatively carried out with the cutting machine of Ar laser loading used for original recording production of CD-ROM etc. Laser irradiated the part which makes vertical coercive force Hc high at that time. That is, except for the part of the servo pattern which consists of an array of an ellipse field with a clock pattern with a width of face of 2 micrometers shown in drawing 3 and a width of face [of 2 micrometers], and a die length of 5 micrometers, almost all parts were irradiated including the data area.

[0038] The vertical coercive force Hc was measured with the oscillatory type sample magnetization measuring device to the film surface of the magnetic film 3 in a magnetic-recording medium, the field 12 which irradiated laser using the test piece produced to coincidence, and the field which is not irradiated. Consequently, in the field 12 which irradiated laser, Hc(s) were 1720Oe(s), and Hc(s) were 1480Oe(s) in the field which is not irradiated. As drawing 4 explained this magnetic-recording medium, after demagnetizing twice by DC field which changed that polarity and magnitude, when it included in the magnetic storage of the common knowledge which shows an outline to drawing 12 and reproduced by spacing 0.07micrometer and peripheral-speed 10 m/s using the MR head, the positioning signal was able to be acquired by S/N ratio 3.5.

[0039] [Example 6] Drawing 10 is a cross section equivalent to drawing 1 of other examples of the magnetic-recording medium by this invention. On the front face of the single crystal mica substrate 1, the resist pattern was formed by the photolithography method. This resist film was used as the mask and the pit with a depth of 30nm was formed in the mica substrate 1 by the ion milling using Ar gas. Then, 30nm of Ti film which carried out electron beam evaporation to the pit of the mica substrate 1 as substrate film 2 by the lift-off method was embedded. Sputter etching of the obtained sample was carried out lightly after an appropriate time, 30nm electron beam evaporation of the Co was carried out as a magnetic film 3 on it, and 10nm spatter membrane formation of the carbon film was carried out as a protective coat 4 on it.

[0040] The vertical coercive force Hc was measured with the oscillatory type sample magnetization measuring device to the film surface of the magnetic film 3 in a magnetic-recording medium, the field which has Ti substrate film 2 using the test piece produced to coincidence, and the field which is not. Consequently, in the field with Ti substrate film 2, Hc(s) were 1030Oe(s), and Hc(s) were 750Oe(s) in the field without Ti substrate film 2. As drawing 4 explained this magnetic-recording medium, after demagnetizing twice by DC field which changed that polarity and magnitude, when it included in the magnetic storage of the common knowledge which shows an outline to drawing 12 and reproduced by spacing 0.07micrometer and peripheral-speed 10 m/s using the MR head, the positioning signal was able

to be acquired by S/N ratio 2.2.
[0041] [Example 7] Drawing 11 is a cross section equivalent to drawing 1 of other examples of the magnetic-recording medium by this invention. On the front face of the quartz substrate 1, 20nm spatter membrane formation of the Ti film was carried out as substrate film 2. Next, CCl4 after forming a resist pattern by the photolithography method By reactive ion etching using gas, the existence of Ti substrate film 2 was formed according to the servo pattern. Sputter etching of the obtained sample is carried out lightly after an appropriate time, and it is CoCr17Ta3 as a magnetic film 3 on it. 50nm spatter membrane formation was carried out, and 10nm spatter membrane formation of the carbon film was carried out as a protective coat 4 on it.
[0042] The vertical coercive force Hc was measured with the oscillatory type sample magnetization measuring device to the film surface of the magnetic film 3 in a magnetic-recording medium, the field which has Ti substrate film 2 using the test piece produced to coincidence, and the field which is not. Consequently, in the field in which no Hc of 1510Oe(s) and two Ti substrate film is in a field with Ti substrate film 2, Hc(s) were 520Oe(s). As drawing 4 explained this magnetic-recording medium, after demagnetizing twice by DC field which changed that polarity and magnitude, when it included in the magnetic storage of the common knowledge which shows an outline to drawing 12 and reproduced by spacing 0.07micrometer and peripheral-speed 10 m/s using the MR head, the positioning signal was able to be acquired by S/N ratio 4.5.
[0043]
[Effect of the Invention] According to this invention, in the perpendicular magnetic anisotropy films which can record high density more, there is no surface irregularity, or since a very small servo pattern and a ROM pattern can be beforehand formed on a magnetic-recording medium, while being able to aim at improvement in recording density, and improvement in productivity, disk crash can be prevented. Moreover, according to the lithography method, since the minute pattern (about 0.3 micrometers) to the diffraction limitation of light can be formed, the magnetic-domain pattern for servoes of the high density which was not able to be realized by the conventional servo track writer can be formed. For this reason, Gb/in2 The magnetic disk drive of super-high density of class is realizable.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The vertical-magnetic-recording medium characterized by making into the servo signal for magnetic-head positioning, or the memory signal only for playbacks the signal generated when it has the field which changed vertical magnetic properties to the film surface of a magnetic film alternatively according to the predetermined pattern and said field is scanned by the magnetic head.
[Claim 2] Said magnetic properties are vertical-magnetic-recording media according to claim 1 characterized by being the product of a magnetic anisotropy, residual magnetization, residual magnetization, and thickness, or coercive force.
[Claim 3] The vertical-magnetic-recording medium according to claim 1 or 2 characterized by making the field to which said magnetic properties were alternatively changed by changing reinforcement and impressing the field which reversed the polarity generate a magnetic domain alternatively.
[Claim 4] The vertical-magnetic-recording medium characterized by having prepared the substrate film for orientation control of said magnetic film between the nonmagnetic substrate and the magnetic film, and forming the servo pattern for magnetic-head positioning, or the memory pattern only for playbacks in this substrate film.
[Claim 5] The existence of said substrate film, or the vertical-magnetic-recording medium according to claim 4 characterized by having made said servo pattern or the memory pattern only for playbacks correspond, and changing thickness.
[Claim 6] The vertical-magnetic-recording medium according to claim 4 characterized by having made said servo pattern or the memory pattern only for playbacks correspond, and changing the ingredient of said substrate film.
[Claim 7] Said substrate film for orientation control is a vertical-magnetic-recording medium according to claim 4, 5, or 6 characterized by consisting of Ti, Ru, germanium, Zr, or Cr.
[Claim 8] Said magnetic film is a vertical-magnetic-recording medium according to claim 4, 5, 6, or 7 characterized by consisting of Co-Cr, Co-Cr-Ta, or Co-Cr-Pt.
[Claim 9] The manufacture approach of the vertical-magnetic-recording medium indicated by claim 5 characterized by including the process which etches the part besides the individual reason equivalent to said servo pattern of the front face of a nonmagnetic substrate, or the memory pattern only for playbacks, the process which forms the substrate film for orientation control of a magnetic film in said etched part, and the process which forms a magnetic film on it.
[Claim 10] The manufacture approach of the vertical-magnetic-recording medium indicated by claim 5 characterized by providing the following The process which etches either of the parts besides the individual reason equivalent to the part equivalent to said servo pattern of the front face of a nonmagnetic substrate, or the memory pattern only for playbacks, said servo pattern, or the memory pattern only for playbacks The process which forms the substrate film for orientation control of a magnetic film on it The process which grinds the front face of said formed substrate film, and is made flat The process which forms a magnetic film on it
[Claim 11] The manufacture approach of the vertical-magnetic-recording medium indicated by claim 5

characterized by providing the following The process which etches the part besides the individual reason equivalent to said servo pattern of the front face of a nonmagnetic substrate, or the memory pattern only for playbacks The process which forms orientation or the 1st substrate film for particle-size control in the etched part The process which forms the 2nd substrate film for orientation control of a magnetic film on said 1st substrate film The process which forms a magnetic film on it

[Claim 12] The manufacture approach of the vertical-magnetic-recording medium indicated by claim 6 characterized by providing the following The process which forms the 1st substrate film for orientation control of a magnetic film on a nonmagnetic substrate The process which removes said 1st substrate film of the part equivalent to said servo pattern or the memory pattern only for playbacks The process which forms the 2nd substrate film for orientation control of a magnetic film in the part which removed said 1st substrate film The process which forms a magnetic film on said 1st substrate film and the 2nd substrate film

[Claim 13] The manufacture approach of the vertical-magnetic-recording medium indicated by claim 2 characterized by including the process which heats the magnetic film of the part besides the individual reason equivalent to the process which forms the substrate film for orientation control of a magnetic film on a nonmagnetic substrate, the process which forms a magnetic film on it, and said servo pattern or the memory pattern only for playbacks using laser.

[Claim 14] The manufacture approach of the vertical-magnetic-recording medium indicated by claim 5 characterized by including the process which forms the substrate film for orientation control of a magnetic film on a nonmagnetic substrate, the process which removes said substrate film of the part equivalent to said servo pattern or the memory pattern only for playbacks, and the process which forms a magnetic film on it.

[Claim 15] The manufacture approach of claims 9, 10, 11, and 12 characterized by including the process which etches the substrate film before the process which forms a magnetic film, or the vertical-magnetic-recording medium of 14 given in any 1 term.

[Claim 16] Magnetic storage characterized by including the vertical-magnetic-recording medium indicated by any 1 term of claims 1-8, the means which carries out the rotation drive of said magnetic-recording medium, the magnetic head, and a means to control the location of said magnetic head by the servo signal generated by the servo pattern prepared in said magnetic-recording medium.

[Claim 17] Magnetic storage according to claim 16 characterized by including a means to reproduce the signal generated by the memory pattern only for playbacks prepared in said magnetic-recording medium.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] One example of the magnetic-recording medium by this invention is a sectional view a part.

[Drawing 2] The production process Fig. of one example of the magnetic-recording medium by this invention.
[Drawing 3] The top view of a magnetic-recording medium.
[Drawing 4] The explanatory view of a magnetization condition.
[Drawing 5] A servo pattern and the explanatory view of a servo signal.
[Drawing 6] Other examples of the magnetic-recording medium by this invention are sectional views a part.
[Drawing 7] Other examples of the magnetic-recording medium by this invention are sectional views a part.
[Drawing 8] Other examples of the magnetic-recording medium by this invention are sectional views a part.
[Drawing 9] Other examples of the magnetic-recording medium by this invention are sectional views a part.
[Drawing 10] Other examples of the magnetic-recording medium by this invention are sectional views a part.
[Drawing 11] Other examples of the magnetic-recording medium by this invention are sectional views a part.
[Drawing 12] The explanatory view of magnetic storage.
[Description of Notations]
1 [-- A protective coat, 5 / -- Ti film, 6 / -- TiCr film,] -- A substrate, 2 -- The substrate film, 3 -- A magnetic film, 4 11 -- Lubricant, 12 -- The laser radiation part in a magnetic film, 13 -- The low coercive force part in a magnetic film, 14 [-- A clock pattern, 23 / -- A servo pattern, 30 / -- A resist, 40 / -- The magnetic head, 41 / -- Anti-field which acts on each magnetic domain in a magnetic film] -- The high coercive force part in a magnetic film, 15 -- Cr film, 20 -- A servo field, 21, 22, 24, 25

[Translation done.]

* NOTICES *

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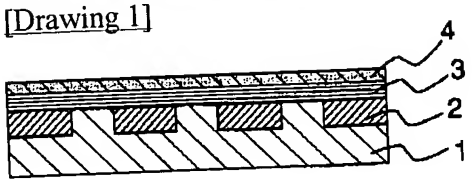
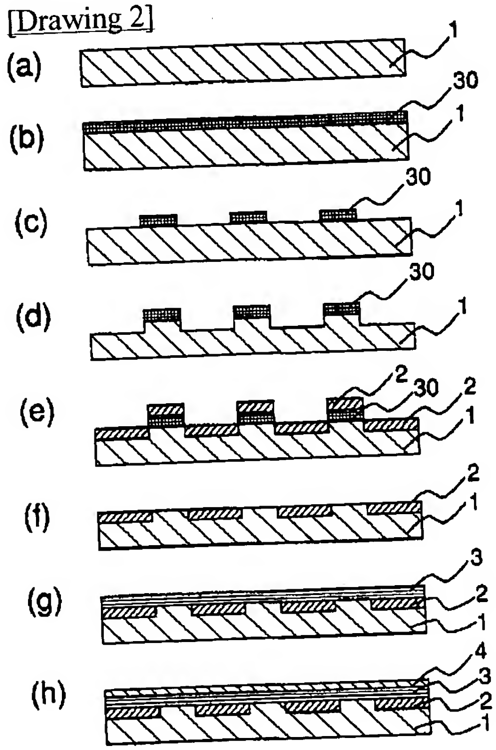
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

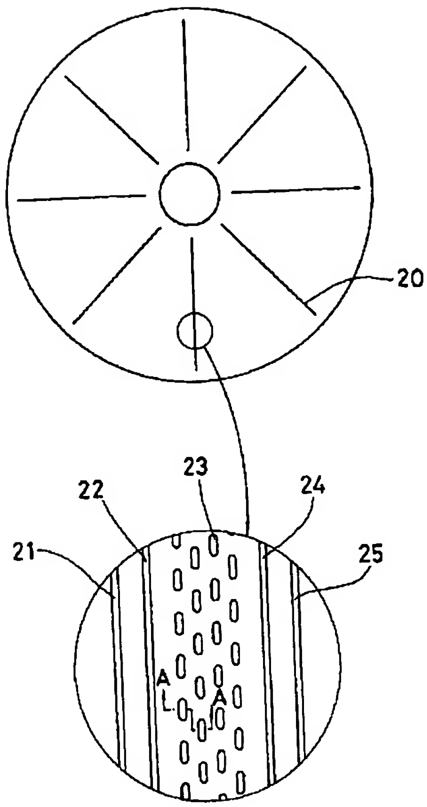
[Drawing 1]



[Drawing 2]



[Drawing 3]



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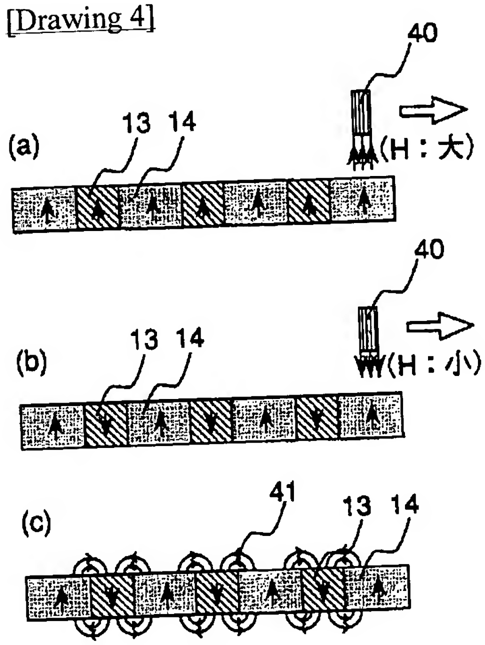

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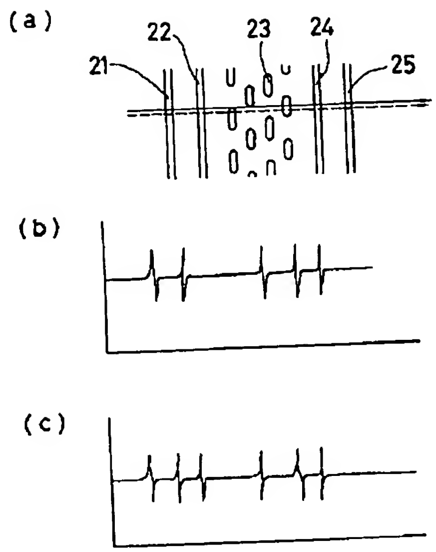

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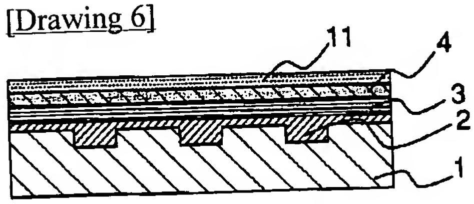
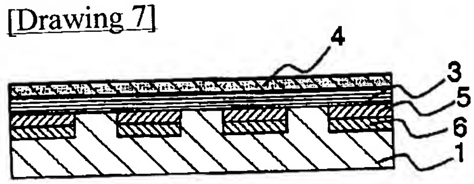


[Drawing 7]



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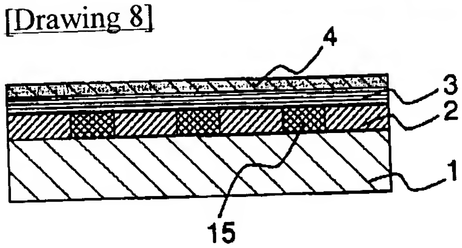
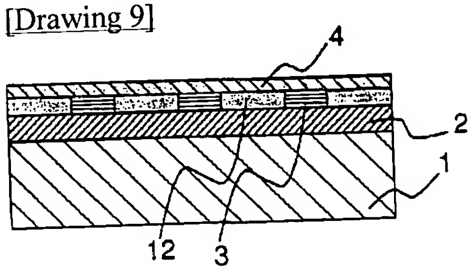
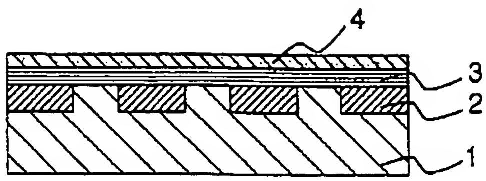


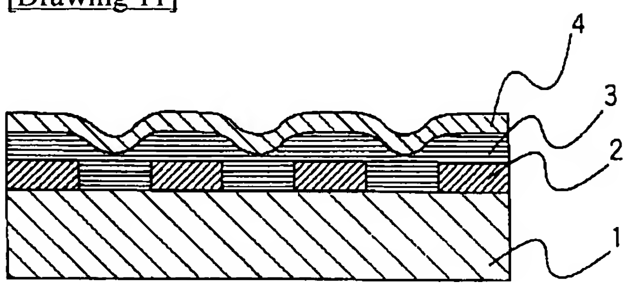
[Drawing 9]



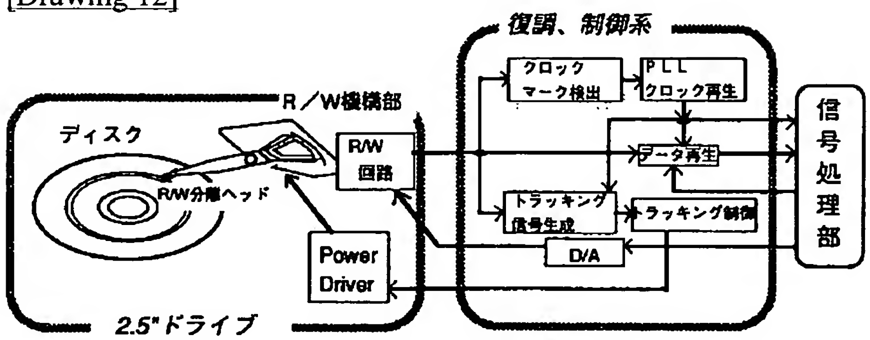
[Drawing 10]



[Drawing 11]



[Drawing 12]



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